Subject Description Form

Subject Code	BME32115
Subject Title	**Biosensors: Theories and Biomedical Applications**
Credit Value	3
Level	3
Prerequisite	ABCT1741 General Chemistry I or BME21148 Biomedical Electronics
Objectives	Biosensors that detect and measure a great variety of clinically relevant biomolecules play an important role in the field of biomedical engineering and medical laboratory science. This subject covers the fundamentals of various types of biosensors, in particular the coupling of biorecognition species to signal transducers. The understanding of these principles is crucial to the evaluation of commercial systems/products (e.g., blood glucose meter) as well as the development of new biosensors for emerging healthcare applications in the twenty-first century.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. Describe the working principles of biosensors in terms of their biorecognition elements (e.g., enzyme, antibody, and nucleic acid) and signal transduction schemes (e.g., optical, electrochemical/electrical, and mass-sensitive); b. Evaluate the performance of biosensors (e.g., sensitivity and selectivity) and critically compare different commercial devices; c. Apply the fundamental principles to design novel biosensors for biomedical applications; d. Appreciate the importance of biosensors in biomedical engineering/medical laboratory science and identify future opportunities/directions.
Contribution to Programme Outcomes (Refer to Part I Section 10)	▪ Programme Outcome 1: Demonstrate an ability to apply knowledge of mathematics, science, and engineering appropriate to the Biomedical Engineering (BME) discipline. (Teach) ▪ Programme Outcome 2: Demonstrate an ability to design and conduct BME experiments, as well as to analyze and interpret data. (Teach) ▪ Programme Outcome 3: Demonstrate an ability to design a system, component, or process relevant to BME to meet desired needs within realistic constraints, such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability. (Teach and Practice)

	▪ Programme Outcome 4: Demonstrate an ability to identify, formulate, and solve BME problems. (Teach and Practice) ▪ Programme Outcome 5: Demonstrate an ability to understand the impact of BME solutions in a global and societal context, especially the importance of health, safety, and environmental considerations to both workers and the general public. (Teach) ▪ Programme Outcome 6: Demonstrate an ability to critically evaluate research and professional literature, and understand the principles and practice of conducting research in clinical and industrial environments relevant to BME. (Teach and Practice) ▪ Programme Outcome 7: Demonstrate an ability to use the techniques, skills, and modern engineering tools necessary for BME practice. (Teach) ▪ Programme Outcome 9: Demonstrate an ability to function in multi-disciplinary teams. (Teach) ▪ Programme Outcome 11: Demonstrate an ability to communicate effectively and advise clients, professional colleagues, and other members of the community. (Practice) ▪ Programme Outcome 12: Demonstrate an ability to recognize the need for, and to engage in life-long learning. (Teach and Practice) ▪ Programme Outcome 13: Demonstrate an understanding of contemporary issues. (Teach)
Subject Synopsis/ Indicative Syllabus	▪ Biorecognition elements ▪ Immobilization of biorecognition elements onto transducer surfaces ▪ Optical transduction methods (e.g., absorption, fluorescence, luminescence, and surface plasmon resonance) ▪ Electrochemical/electrical transduction methods (e.g., potentiometry, amperometry, and field-effect transistor) ▪ Mass-sensitive transduction methods (e.g., piezoelectric) ▪ Performance factors ▪ Enzyme biosensors ▪ Affinity biosensors ▪ Microtechnology and nanotechnology for biosensor applications
Teaching and Learning Methodology	Students will learn the biosensor principles in lectures. Laboratory demonstrations will enable students to gain experience on the practical aspects of biosensors. Group project will allow students to apply what they learn in- class and to understand future directions of biosensors for emerging biomedical applications.

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed (Please tick as appropriate)							
		a	b	c	d				
Assignment	10%	√	√	√					
Group project	25%	√	√	√	√				
Midterm exam	25%	√	√	√					
Final exam	40%	√	√	√					
Total	100%								

Note: To pass this subject, students must obtain grade D or above in both continuous assessment and final examination.

Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

Assignment: Written assignment is included regarding the working principles, evaluation, and design of biosensors;

Group project: Students have to explore the state-of-the-art biosensors and give an oral presentation;

Midterm exam: Questions are set to assess students' understanding of the working principles, evaluation, and design of different types of biosensors;

Final exam: Questions are set to assess students' understanding of the working principles, evaluation, and design of different types of biosensors.

Student Study Effort Expected

Class contact:	
▪ Lectures	36 Hrs.
▪ Lab demonstrations	3 Hrs.
Other student study effort:	
▪ Assignment and group project	39 Hrs.
▪ Self-study	39 Hrs.
Total student study effort	117 Hrs.

Reading List and References	▪ Mahapatra, D., Singh, L., and Kumar, S., Multifaceted Bio-Sensing Technology, Academic Press, 2023. ▪ Ozkan, S. A., Biosensors: Fundamentals, Emerging Technologies, and Applications, CRC Press, 2023. ▪ Das, J., Biosensors for Emerging and Re-Emerging Infectious Diseases, Academic Press, 2022. ▪ Denizli, A. and Saylan, Y., Biosensors for Virus Detection, IOP Publishing, 2022. ▪ Khan, R., Parihar, A., Kaushik, A. K., and Kumar, A., Advanced Biosensors for Virus Detection Smart Diagnostics to Combat SARS-CoV-2, Academic Press, 2022. ▪ Sezginturk, M. K., Commercial Biosensors and Their Applications: Clinical, Food, and Beyond, Elsevier, 2020. ▪ Pandey, C. M. and Malhotra, B. D., Biosensors: Fundamentals and Applications, De Gruyter, 2019. ▪ Ensafi, A. A., Electrochemical Biosensors, Elsevier, 2019. ▪ Knopf, G. K. and Bassi, A. S., Smart Biosensor Technology, CRC Press, 2019. ▪ Narang, J. and Pundir, C. S., Biosensors: An Introductory Textbook, Pan Stanford, 2017. ▪ Altintas, Z., 1., Biosensors and Nanotechnology: Applications in Health Care Diagnostics, Wiley, 2017. ▪ Malhotra, B. D. and Ali A., Nanomaterials for Biosensors: Fundamentals and Applications, Elsevier, 2017. ▪ Kintzios, S. E., Portable Biosensors and Point-of-Care Systems, The Institution of Engineering and Technology, 2017. ▪ Narayan, R. J., Medical Biosensors for Point of Care (POC) Applications, Woodhead Publishing, 2016. ▪ Karunakaran, C., Bhargava, K., and Benjamin, R., Biosensors and Bioelectronics, Elsevier, 2015. ▪ Evtugyn, G., Biosensors: Essentials, Springer, 2014. ▪ Banica, F.-G., Chemical Sensors and Biosensors: Fundamentals and Applications, Wiley, 2012. ▪ Higson, S., Biosensors for Medical Applications, Woodhead Publishing, 2012.
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